6.0 GROUNDWATER MONITORING PROGRAM

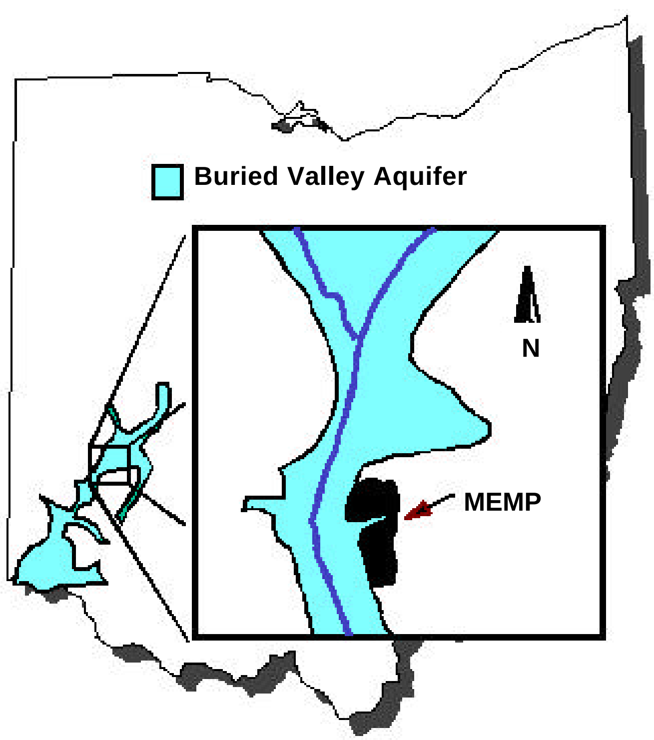
The MEMP site lies along and atop of a portion of Ohio's largest sole-source aquifers, the Buried Valley Aquifer (BVA). The City of Miamisburg and a number of other communities in the area draw drinking water from the BVA. MEMP also relies on the BVA for drinking and process water.

MEMP maintains approximately 175 active groundwater monitoring points onsite and offsite to characterize the impact operations may have on the BVA. Included in these sites are three onsite production wells, 117 monitoring wells, 38 piezometers, five capture pits, and 13 community water supplies and private wells. The groundwater monitoring program has been developed to meet Safe Drinking Water Act (SDWA) monitoring requirements, CERCLA program objectives, and DOE-mandated practices. This chapter serves as a general summary of the groundwater activities that have occurred in 2000.

6.1 Regional Hydrogeology

The BVA was designated a sole-source aquifer by the U.S. EPA in May 1988. This distinction indicates that the aquifer supplies all of the drinking water to the communities above it. The approximate aerial extent of the BVA is shown in Figure 6-1.

Figure 6-1. Location and Extent of the Buried Valley Aquifer



The aquifer has a north-south orientation and reaches a maximum thickness of about 46 m (150 ft) near the Great Miami River channel. Groundwater in the area generally flows south, following the downstream course of the River. Limited recharge by induced stream infiltration occurs due to the extensive layers of clayish till in the region, which impede infiltration. The BVA flow system is characterized by glacial outwash deposits with very high hydraulic conductivity, consequently, the aquifer is capable of transmitting large quantities of groundwater. The BVA west of the site is estimated to have calculated transmissivity values ranging from 200,000 to 430,000 gallons per day per foot. The transmissivity values are based upon hydraulic characterization data obtained from a May 1993 aquifer pump test.

The BVA is somewhat overdrawn between the cities of West Carrollton and Dayton. Practices involving relocation of well fields and artificial recharge via infiltration lagoons are in use to reduce the magnitude of the reversal. There is no evidence that the gradient reversal affects regions south of West Carrollton such as Miamisburg. In Miamisburg, pumping does not influence the natural groundwater gradient except in the immediate vicinity of the well fields.

Uses of Groundwater in the Vicinity

There are seven municipal water supplies and numerous industrial users within an 8 km (5 mi) radius of the site. The locations of public and private water supply and monitoring wells are shown in Figure 6-2. The only industrial user within 8 km (5 mi) downgradient is the O. H. Hutchings Power Generation Station. Industrial groundwater users located north (upgradient) of the site are isolated from MEMP by hydraulic barriers.

The communities of Franklin and Carlisle are the first downgradient water supplies. Monitoring efforts are concentrated in the Miamisburg area due to the relatively slow movement of groundwater. The City of Miamisburg operates four production wells to the west of the Great Miami River. These wells are upgradient and are not expected to be impacted by MEMP. All community production wells in use are separated from the site by a minimum straight-line distance of 0.8 km (0.5 mi).

In 1992, a residential well and cistern study (DOE, 1993b) was conducted. A total of 216 residential wells and 14 cisterns were identified within a two-mile radius of the site. Results of this study are in the CERCLA Public Reading Room.

6.2 Site Hydrology

As seen in Figure 6-1, a “tongue” of the BVA underlies the site. Within the limits of the property, the maximum known thickness of the aquifer is about 21 m (70 ft) at the extreme southwest corner of the site. Present usage of the BVA by MEMP ranges approximately from 1.23 to 2.27 million liters per day (326,000 to 600,500 gallons per day). Recharge to the portion of the BVA underlying the site primarily arises from infiltration of river water, precipitation, and leakage from valley walls. These sources of recharge provide sufficient volumes of water to balance MEMP’s withdrawals.

As a result of the dramatic changes in elevations associated with site topography, the site has a variety of groundwater regimes. Typical groundwater elevation contour maps, shown in Figures 6-3 and 6-4, reflect the two sources of groundwater that are of concern to MEMP, perched water in the bedrock and the BVA. Groundwater levels vary from elevations near 204 m (670 ft) to approximately 267 m (875 ft). Onsite groundwater levels generally increase with increasing ground surface elevations. (Ground surface elevations are shown on Insert 1-1.) At the lowest site elevations overlying the BVA, groundwater is typically present at depths between 6 m (20 ft) and 25 ft (7 m) below the surface. The maximum groundwater level for the perched water in the bedrock beneath the main hill is approximately 255 m (835 ft). The ground surface elevation for the main hill is approximately 268 m (880 ft).

Bedrock permeability. The bedrock flow system is comprised of thick sequences of interbedded shales and limestones that make-up the topographic bedrock highs known as the Main Hill and SM/PP Hill. The bedrock is not capable of transmitting large quantities of water due to its low hydraulic conductivity. Groundwater flow in the bedrock system occurs primarily within an upper fracture carapace that extends from the ground surface to a depth of approximately 50 ft. The fracture carapace is characterized by bedrock that contains sufficient interconnected secondary porosity to allow transmission of small quantities of groundwater. Permeability of this carapace is estimated to range from 40 to 400 L/day/m^2 (1 to 10 gal/day/ft^2). Below it, bedrock permeability generally ranges from 0 to 8 L/day/m^2 (0 to 0.2 gal/day/ft^2). Bedrock groundwater typically discharges as either surface seeps or into onlapping portions of glacial deposits.

Glacial till and outwash permeability. Hydraulic properties of the glacial tills that form a veneer over the site vary depending on the proportions of fine and course-grained materials at a given location. Values of permeability normally range from 0.0041 to 0.041 L/day/m^2 (0.0001 to 0.001 gal/day/ft^2), although values up to 2.8 L/day/m^2 (0.07 gal/day/ft^2) have been measured in upper weathered zones. Below the glacial till in the lower valley is a zone of glacial outwash composed of sand and gravel. The permeability of this zone is estimated to range from 40,700 to 81,000 L/day/m^2 (1,000 to 2,000 gal/day /ft^2). Additional information concerning the site's hydrology can be found in *"Operable Unit 9, Hydrologic Investigation, 1994"* (Bedrock and Buried Valley Aquifer Reports).

Seeps

At points along the northern and western portions of the hillside, bedrock is exposed and seep lines exist. A generalized cutaway depicting this phenomenon is shown in Figure 6-5. Seeps serve as escape routes for groundwater in the upper elevations of the groundwater regime.

Surface Water Features

There are no perennial streams on the site. A natural drainage area exists in the deep valley separating the two main hills, but water in this area generally has a short residence time. The basin is relatively small and the slopes are relatively steep. Therefore, runoff through site drainage features is rapid.

Figure 6-2. Production and Monitoring Well Locations


0330
GREAT MIAMI RIVER
PLANT BOUNDARY
MOUND ROAD
0395
0430
0431
0111
0308
0119
0346
0345
0123
0386
0347
0389
0314
0125
0315
0326
N
0127
0302
0128
0909
0343
0303
0383
0387
0392
0379
0420
0421
P001,
0313
0422
P003
0370, P002
0907
0388
0397
0373
0308
0906
0423
P005
0376
0382
0904
0377
0419
0410
0905
P015
0378
0071
0411
0353
P027
0304
P025
0271
0342
P044
P031
0317
P045
0402
P046
0063, 0305, 0374,
0415, 0416, 0417,
0418, 0424, 0425,
P043
0076
0400
CONRAIL TRACKS
0354
0344
0319
0320
0356
PLANT BOUNDARY
BENNER ROAD
0158

Figure 6-3. Groundwater Elevations for Perched Water in the Bedrock

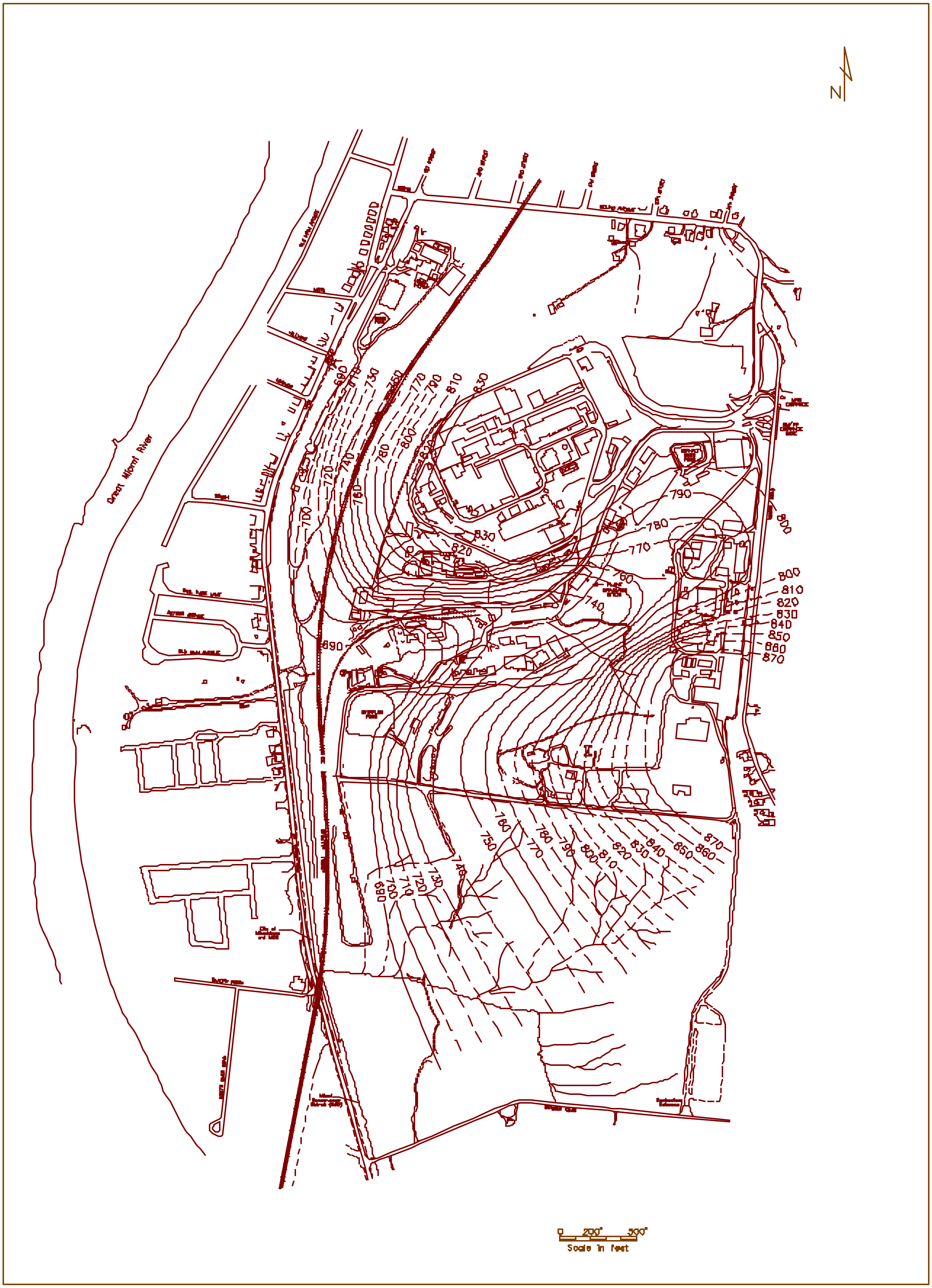

Great Miami River
N
Scale in Feet

Figure 6-4. Groundwater Elevations for the Buried Valley Aquifer

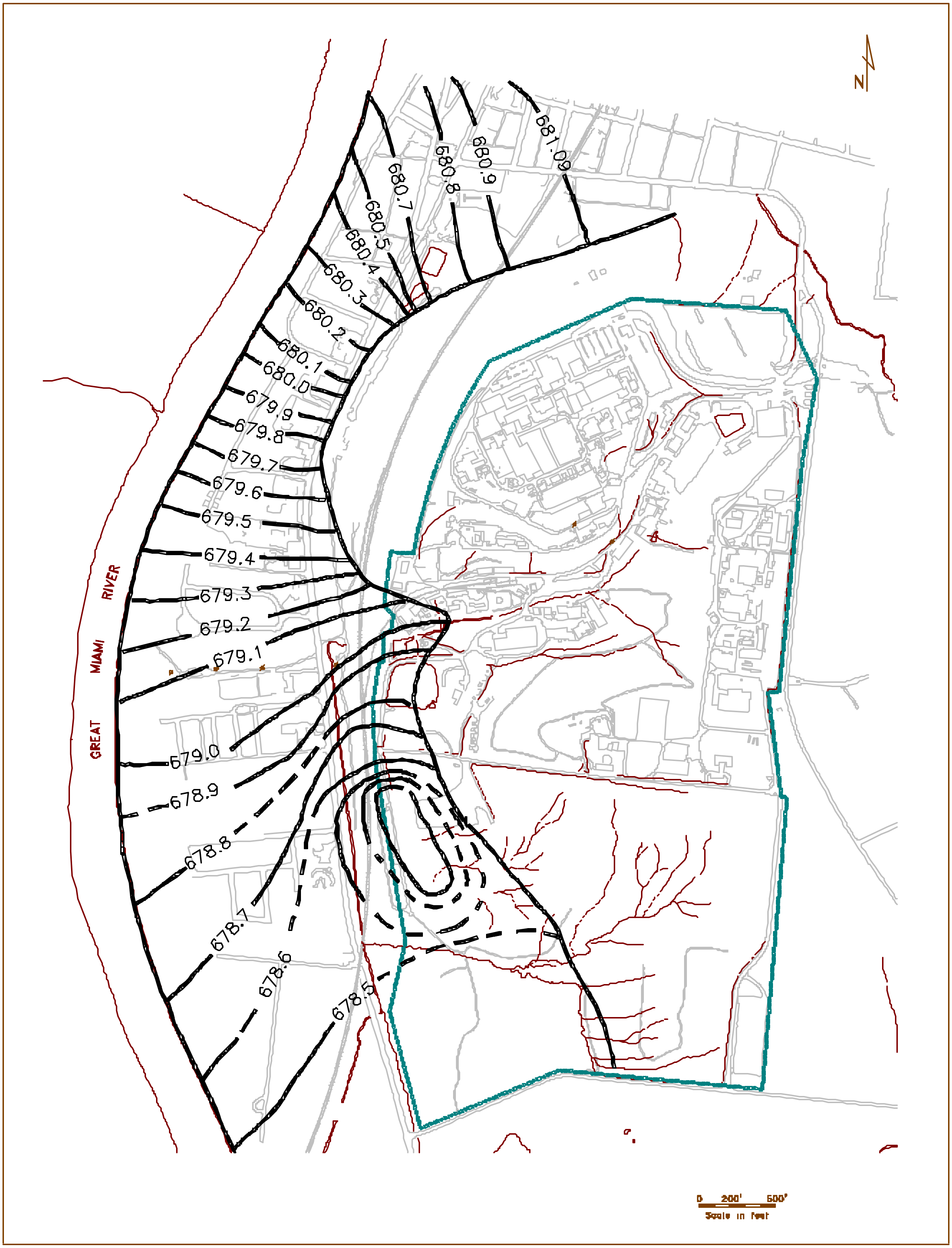
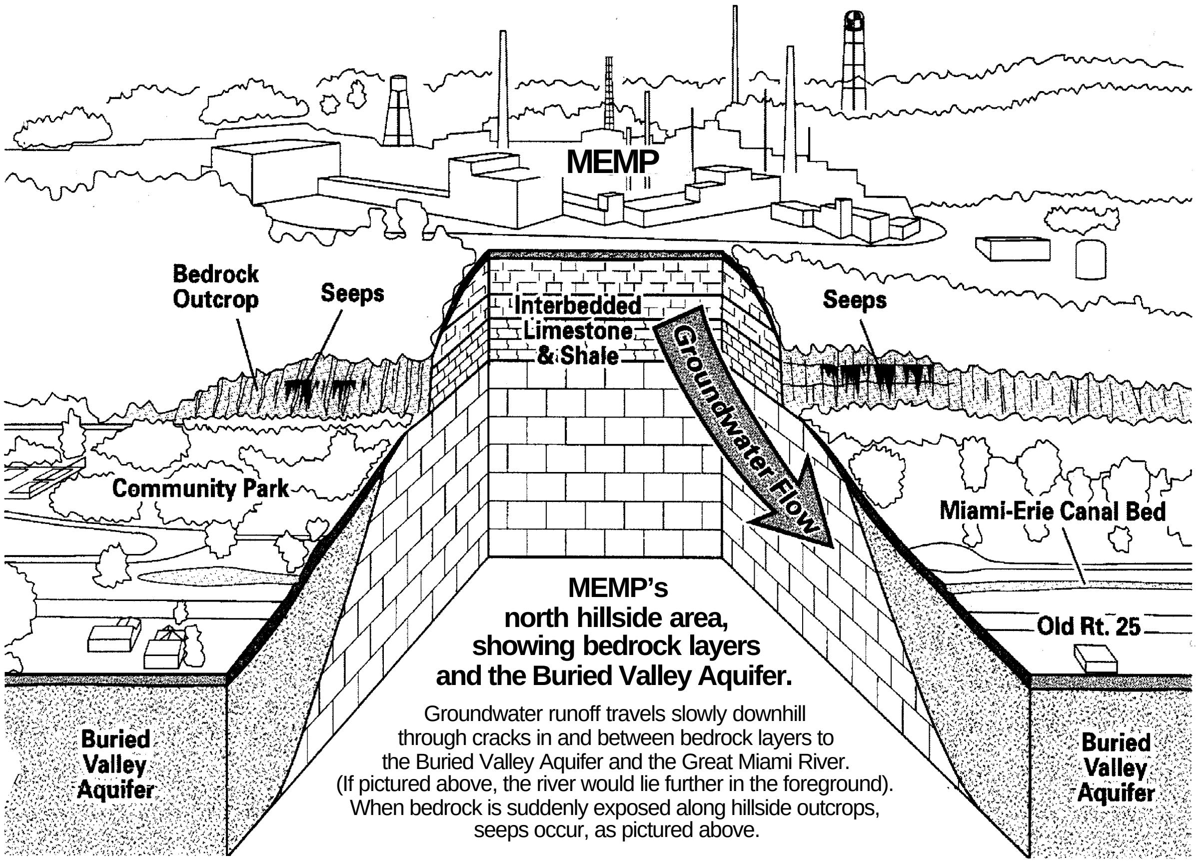

N
681.09
680.9
680.8
680.7
680.5
680.4
680.3
680.2
680.1
680.0
679.9
679.8
679.7
679.6
679.5
679.4
679.3
679.2
679.1
679.0
678.9
678.8
678.7
678.6
678.5
GREAT MIAMI RIVER
0 200' 500'
Scale in feet

Figure 6-5. Geologic Cutaway



6.3 Applicable Standards

Guidelines for concentrations of radionuclides in drinking water are provided in DOE Order 5400.5 (DOE, 1993). These guides are based on recommendations in Publications 26 and 30 of the International Commission on Radiological Protection (ICRP 1977, 1979). The guides for radionuclide concentrations are referred to as DCGs. The DCG for a radionuclide is defined as the concentration of that radionuclide which will result in a 50-year CEDE of 100 mrem (1 mSv) following continuous exposure for one year. EPA has also established a drinking water dose standard of 4 mrem/year for specific combinations of radionuclides and concentration standards, or maximum contaminant levels (MCLs), for tritium, radium, and gross alpha.

The National Primary and Secondary Drinking Water Standards also provide MCLs for nonradiological parameters. Primary MCLs have been established for a variety of parameters, including volatile organic compounds (VOCs) and inorganic substances such as metals. Primary MCLs are the maximum concentrations allowed under the SDWA. Secondary MCLs are guidelines for maximum advisable concentrations for other contaminants. Maximum concentrations of lead and copper are expressed as "action levels." DCGs, MCLs, and action levels are included with the groundwater results presented in Appendix D.

6.4 Environmental Concentrations

Each year, samples are collected from a community water supply that is not affected by MEMP operations. These samples represent background, or "environmental," levels for radionuclides. For drinking water, the environmental reference location is Tipp City, approximately 40 km (25 mi) north of MEMP. Environmental concentrations for 2000 can be found in Appendix D, Table D-1.

6.5 Offsite Groundwater Monitoring Program

The objectives of the offsite groundwater monitoring program are to assure local residents and communities that their drinking water has not been adversely impacted by plant activities and to provide an early warning of impacts due to continuing decontamination and decommissioning activities and environmental restoration activities. This program consists of the collection and analysis of samples from production wells, private wells, regional drinking water supplies, and BVA monitoring wells. Samples are analyzed for radionuclides, inorganic substances, and VOCs. A description of the analytical procedures used to generate these results can be found in the Environmental Monitoring Plan (BWXTO, 2000) and the Groundwater Protection Management Program Plan (DOE, 1997).

Community Water Supplies and Private Wells

Tritium is the most mobile of the radionuclides released from the site. Therefore, private wells immediately downgradient of MEMP and regional groundwater supplies are closely monitored for tritium. Monthly samples are collected from seven community water supplies and six private wells. Results for 2000 are shown in Appendix D, Table D-2. Average tritium concentrations ranged from 0.09 nCi/L to 0.17 nCi/L, or 0.5% to 0.9% of the MCL, respectively. The results reflect the pattern of tritium concentrations one would expect: higher averages near the site (e.g., Miamisburg) and lower averages at greater distances (e.g., Middletown).

The Miamisburg community water supply is also analyzed for plutonium-238, plutonium-239,240, uranium-233,234, uranium-238, thorium-228, thorium-230, and thorium-232. Plutonium and uranium samples are collected monthly, while thorium samples are collected quarterly. Results for 2000 are shown in Appendix D, Tables D-3 through D-5. Many results for 2000 were comparable to background levels for these radionuclides; average concentrations were less than 3.1% of the respective EPA dose standard.

Offsite Monitoring Wells

Radionuclides. To provide additional information on the extent of offsite tritium migration, MEMP also collects groundwater samples from offsite monitoring wells. The results for 2000 are shown in Appendix D, Table D-6. Average tritium concentrations ranged from 0.13 nCi/L to 7.33 nCi/L, or 0.7% to 36.7% of the MCL, respectively.

Monitoring wells along the western boundary of the site are also analyzed for plutonium-238, plutonium-239,240, uranium-233,234, uranium-235, uranium-238, thorium-228, thorium-230, and thorium-232. The results are shown in Appendix D, Tables D-7 through D-9. Average concentrations ranged from non-detectable to 2.4% of the respective EPA dose standard.

VOCs and Inorganics. Thirteen offsite monitoring wells were also used to evaluate concentrations of VOCs in the BVA. The wells sampled were analyzed for over 50 organic compounds. Results are presented in Appendix D, Table D-10. Historical contaminants, such as tetrachloroethene, trichloroethene, 1,1,1-trichloroethane, were observed in approximately half of the offsite wells monitored in 2000. No MCLs were exceeded in 2000. In addition to the historical contaminants, trihalomethanes (THMs) have been detected in nine of the thirteen monitoring wells. THMs (bromoform, chloroform, bromodichloromethane, and dibromochloro-methane) are generally considered disinfection-by-products from chlorination. THMs were introduced into the aquifer as a result of a valve failure at the old Miamisburg Well #2. Chlorinated potable water from the City of Miamisburg leaked into the aquifer for approximately nine months before the leak was found.

Inorganic substances are also evaluated in offsite monitoring wells. The metals and other inorganics of interest are those regulated under the SDWA. In 2000, only those parameters with MCL detectable concentrations are presented in Appendix D, Table D-11. In 2000, a concentration above primary MCLs was observed for nickel. Secondary MCLs were exceeded for aluminum, iron, and manganese. In 1999, a field investigation was initiated to study the nature and variability of the elevated levels of metals. The study results suggested that turbidity induced by the sampling methodology was the primary factor for the variability in metal concentrations. Results and sampling recommendations from the field investigation can be found in *"Metals Investigation Assessment Report, US Department of Energy, October, 1999."* A change in sampling methodology will be implemented in calendar year 2001.

6.6 Onsite Groundwater Monitoring Program

The objectives of the onsite groundwater monitoring program are to assure site workers that drinking water is safe for consumption, to assure containment of known groundwater contamination, and to monitor progress and effectiveness of ongoing groundwater remediation efforts. This program consists of routine collection and analysis of samples from production wells and BVA monitoring wells. Samples are analyzed for radionuclides, inorganic substances, and VOCs. A description of the analytical procedures used to generate these results can be found in the Environmental Monitoring Plan (BWXTO, 2000) and the Groundwater Protection Management Program Plan (DOE, 1997).

MEMP Production Wells

Three onsite production wells provide drinking and process water for the site. Samples from the production wells are analyzed for tritium, plutonium-238, plutonium-239,240, uranium-233,234, uranium-238, thorium-228, thorium-230, and thorium-232. Tritium samples are collected and analyzed weekly, plutonium and uranium samples monthly, and thorium quarterly. Results for 2000 are summarized in Appendix D, Tables D-12 through D-15. Average tritium concentrations observed in 2000 were less than 0.5 nCi/L. This value represents less than 2.0% of the MCL. Average concentrations of other radionuclides measured in 2000 in production wells represented less than 1.3% of the respective EPA dose standard.

MEMP's production wells are also analyzed for over 50 organic compounds quarterly each year. The three halogenated solvents typically present in trace concentrations are 1,1,1-trichloroethane, trichloroethene, and tetrachloroethene. As seen in the offsite monitoring wells, THMs have shown up in two of the production wells. Since THM concentrations are larger offsite than onsite, results would indicate that the THMs are being drawn onsite by the production wells large cone of influence as seen in Figure 6-4. Results for 2000 are shown in Appendix D, Table D-16. The data confirm that the production wells are consistently below MCLs for organic compounds.

SDWA Compliance Summary

Results in this Chapter have been summarized in terms of average concentrations for the year. SDWA compliance for drinking water supplies, however, is evaluated by comparing individual sample results with applicable MCL values. Because the three onsite production wells serve as a drinking water source for the site, SDWA compliance is determined by an annual running average. Table 6-1 shows the maximum concentrations of parameters measured in the production wells during 2000. In 2000, no MCL exceedances were observed in the production wells.

Table 6-1. SDWA Compliance Summary

Parameter	Maximum Concentration	MCL
Tritium	0.8 nCi/L	20 nCi/L
Bromodichloromethane	1.4 µg/L	100 µg/L
Chloroform	1.1 µg/L	100 µg/L
Dibromochloromethane	0.9 µg/L	100 µg/L
1,1,1-Trichloroethane	2.0 µg/L	200 µg/L
Trichloroethene	1.1 µg/L	5 µg/L
Tetrachloroethene	0.7 µg/L	5 µg/L

MCL = Maximum Contaminant Level (based on EPA Drinking Water Standards)

The SDWA does not limit the concentrations of most radionuclides individually (tritium is an exception). Instead, the dose from specific combinations of radionuclides is limited to 4 mrem/year. In 2000, the dose from plutonium, uranium, and thorium measured in the onsite production wells was 0.08 mrem. This represents 2.0% of the dose standard.

To demonstrate compliance with the SDWA, samples are collected from the distribution system. These samples are analyzed for gross alpha and beta, radium, tritium, total coliform, lead, copper, nitrate, inorganics, and volatile organic compounds. No exceedances were observed in 2000.

Onsite Monitoring Wells

Radionuclides. MEMP maintains an extensive network of onsite BVA monitoring wells (Figure 6-2). Samples from these wells are analyzed for tritium. The results for 2000 are shown in Appendix D, Table D-17. The maximum average concentration observed in 2000 was 10.25 nCi/L. This value represents 51.2% of the MCL.

Samples from onsite monitoring wells located in the tributary valley are also analyzed for plutonium-238, plutonium-239,240, uranium-233,234, uranium-235, uranium-238, thorium-228, thorium-230, thorium-232, radium-226, and radium-228. Monitoring for these constituents are part of the PRS 66 field investigation. Results for 2000 are shown in Appendix D, Tables D-18 through D-21. In 2000, average values ranged from below detection limits to 48.7% of the respective EPA dose standard.

VOCs and Inorganics. Onsite monitoring wells in the upper and lower units of the BVA have been sampled since 1988. Results confirm the presence of VOC contamination in the aquifer. The contamination appears to be greatest in the upper unit of the BVA along the western boundary, immediately southwest of the Main Hill. Generally, within the site boundaries, contamination tends to decrease from west to east and from south to north.

The CERCLA OU1 project addresses VOC contamination in groundwater near the site's former solid waste landfill. The project is comprised of two elements: a groundwater pump and treat system designed to prevent the migration of VOCs into the aquifer and an air sparge/soil vapor extraction system to accelerate the removal of VOCs from the soil.

Onsite monitoring wells are sampled for over 50 organic compounds. Many of the wells are sampled to evaluate containment of the plume and the effectiveness of the OU1 treatment process. A declining trend in VOC concentrations has been observed. Results for 2000 are presented in Appendix D, Table D-22. In 2000, carbon tetrachloride, cis-1,2-dichloroethene, trichloroethene, and tetrachloroethene exceeded drinking water MCLs. In addition to the historical contaminants, THMs have been detected in approximately half of the onsite monitoring wells.

Inorganic substances in onsite monitoring wells are also evaluated. The metals and other inorganics of interest are those regulated under the SDWA. The results are presented in Appendix D, Table D-23. In 2000, concentrations above primary MCLs were observed for arsenic, chromium, and nickel. Secondary MCLs were exceeded for aluminum, iron, and manganese. In 1999, a field investigation was initiated to study the nature and variability of the elevated levels of metals. The study results suggested that turbidity induced by the sampling methodology was the primary factor for the variability in metal concentrations. Results and sampling recommendations from the field investigation can be found in *"Metals Investigation Assessment Report, US Department of Energy, October, 1999."* A change in sampling methodology will be implemented in calendar year 2001.

6.7 Seeps and Capture Pits

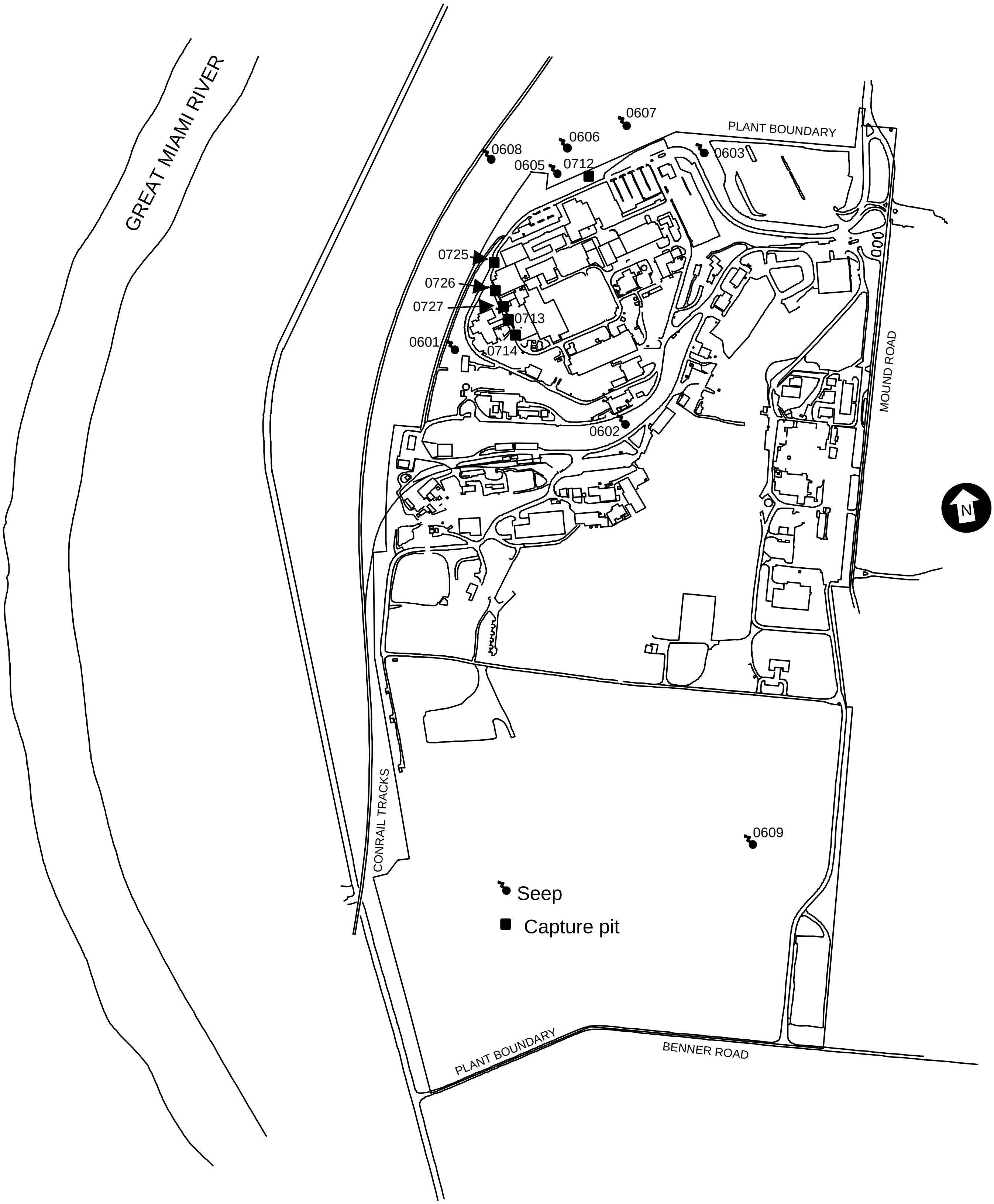
Seeps. Tritium has been recognized as a contaminant in the seeps located along the northwest border of the site since 1986. Since then, tritium has been the focus of extensive sampling activities in that area. Appendix D, Table D-24 shows concentrations of tritium in seep samples in 2000. In 2000, the highest tritium concentrations were associated with Seep 601, consistent with observations in previous years. The sampling locations are shown on Figure 6-6.

Samples collected in 1988 first confirmed the presence of VOCs in Seeps 0601, 0602, 0605, and 0607 (EG&G, 1991). VOC monitoring results for the seeps in 2000 are presented in Appendix D, Table D-25. In 2000, trichloroethene and tetrachloroethene were observed at concentrations greater than the drinking water MCL.

Capture Pits. A number of groundwater collection devices, or "capture pits," are used on the Main Hill to isolate and monitor contamination in perched groundwater. These devices have been designed to collect pockets of shallow groundwater which may have been contaminated as a result of past operational practices. In 2000, samples were collected from the capture pits and analyzed for tritium. The results are shown in Appendix D, Table D-26. The sampling locations are shown on Figure 6-6.

Monitoring in previous years has indicated that the VOC contamination exists in the capture pits. The results are shown in Appendix D, Table D-27. In 2000, trichloroethene was the only compound to exceed the MCL value.

Figure 6-6. Seep and Capture Pit Locations


GREAT MIAMI RIVER
CONRAIL TRACKS
PLANT BOUNDARY
MOUND ROAD
BENNER ROAD
PLANT BOUNDARY
0607
0606
0608
0605
0712
0603
0725
0726
0727
0713
0601
0714
0602
0609
N
Seep
Capture pit

6.8 Five-Year Trends for Wells of Interest

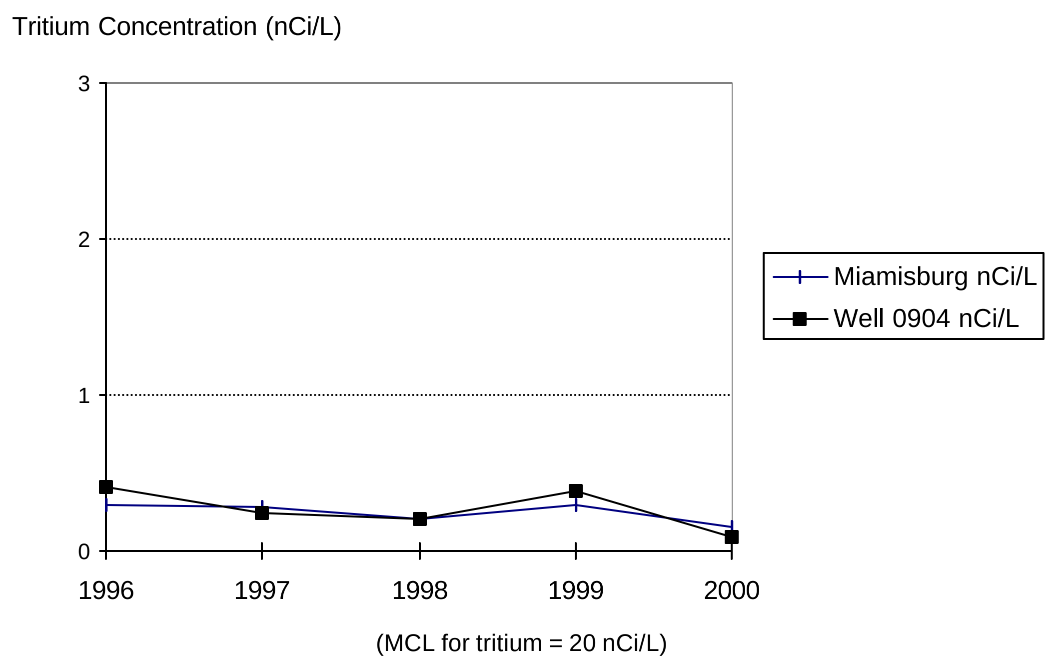
As seen in the preceding sections of this Chapter, a large volume of groundwater monitoring data is generated each year. It is important that the data be reviewed for evidence of long-term trends, especially in cases where there is some history of elevated concentrations of contaminants. In this section, five-year trends are presented for certain indicator parameters measured in wells of interest.

Trend Data for Offsite Drinking Water

A primary consideration of the MEMP environmental monitoring program is to ensure that area drinking water supplies are not adversely affected by activities at the site. The most mobile of the constituents released to groundwater is tritium. For this reason, tritium is an excellent indicator of offsite migration. Two drinking water sources can be considered key receptor wells. First, the drinking water supply of the City of Miamisburg is of interest due to the proximity of the City's well fields. And second, Well 0904, a private well, is useful as an indicator because it reflects potential impact to small drinking water systems.

Five-year trends for tritium concentrations in the two wells described above are shown in Figure 6-7. As seen in the figure, tritium levels in the wells have exhibited little change over the past five years. All of the values are significantly below the MCL for tritium of 20 nCi/L.

Figure 6-7. Annual Average Tritium Concentrations in Offsite Drinking Water, 1996 - 2000



Trend Data for Onsite Production Wells and Seeps

As previously described in this chapter, tritium and certain VOCs have been observed in groundwater underlying the site. The seven halogenated solvents typically present in trace concentrations are carbon tetrachloride, chloroform, cis-1,2-dichloroethene, freon, tetrachloroethene, trichloroethene, and 1,1,1-trichloroethane. Trichloroethene has been the most prevalent contaminant and, therefore, serves as an "indicator" VOC.

An appropriate onsite indicator well is Production Well 0076 (also referred to as Well 3) because it serves as the primary source of drinking water for the site. Other important monitoring points for the evaluation of groundwater conditions are the seeps. Data suggest that Seep 0601 is an appropriate location for the observation of long-term trends.

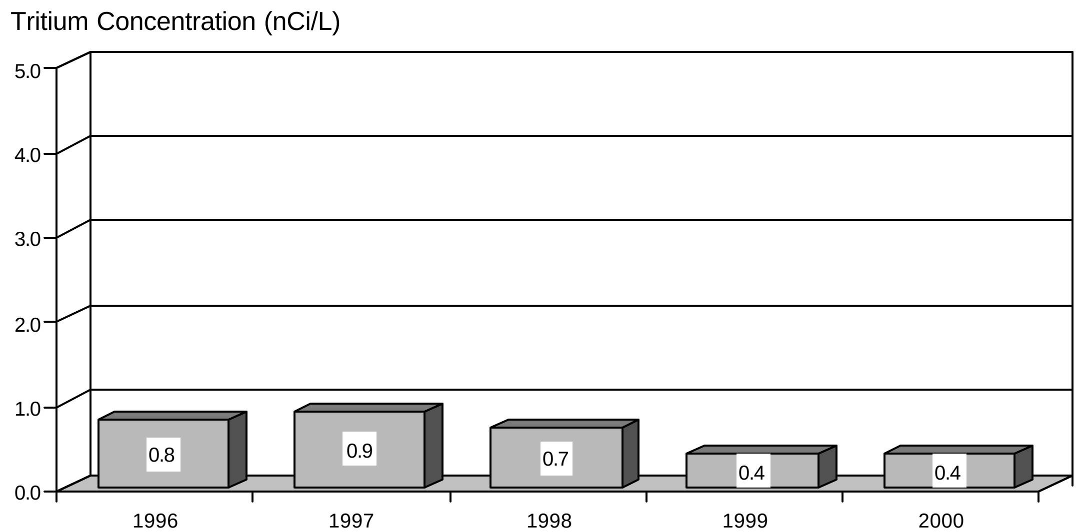
Five-year trend data for Production Well 0076 are shown in Figures 6-8 and 6-9 for tritium and trichloroethene, respectively. Similarly, Figures 6-10 and 6-11 present five-year trend data for tritium and trichloroethene at Seep 0601.

Figure 6-8 indicates that tritium levels in Well 0076 have consistently averaged near 1 nCi/L. This value is well below the applicable MCL (20 nCi/L). Trace concentrations of trichloroethene have also been observed in Well 0076 (Figure 6-9). However, measured concentrations have steadily decreased and remained well below the applicable MCL (5 μg/L).

Figure 6-10 presents tritium concentration data for Seep 0601. Data for the period 1996-2000 show the yearly average for tritium concentrations ranging from approximately 67 nCi/L to 90 nCi/L. Although the average concentrations have varied over the five-year period shown, tritium values have been consistently near or below the 100 nCi/L level the last four years. Seep 0601 is also characterized by elevated levels of trichloroethene. Additionally, though not shown in the figure, tetrachloroethene has also emerged as a contributor to VOC contamination in this seep.

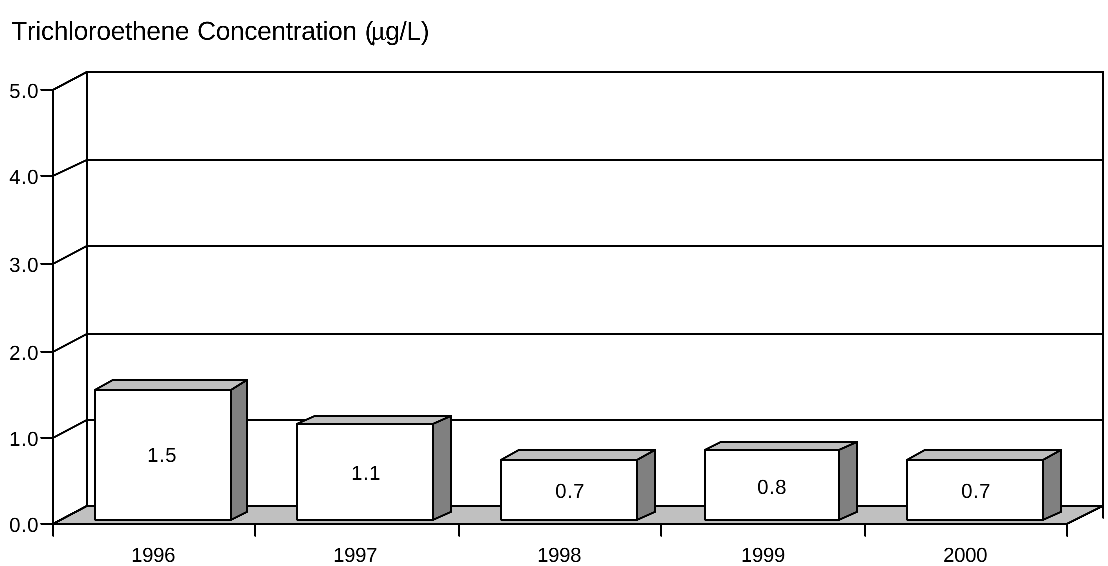
The risks associated with contamination in the seeps will be evaluated under CERCLA and appropriate remediation actions taken if indicated.

Figure 6-8. Annual Average Tritium Concentration in Production Well 0076, 1996 - 2000



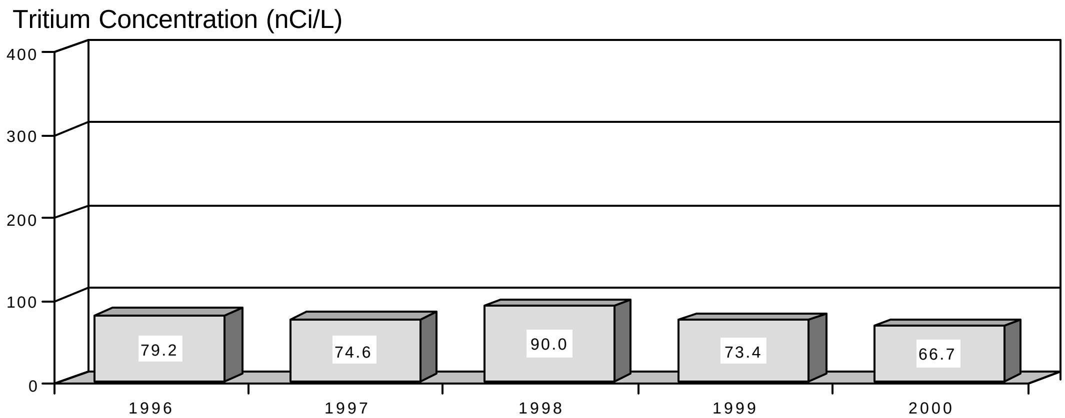
(MCL for tritium = 20 nCi/L)

Figure 6-9. Annual Average Indicator VOC Concentration in Production Well 0076, 1996-2000



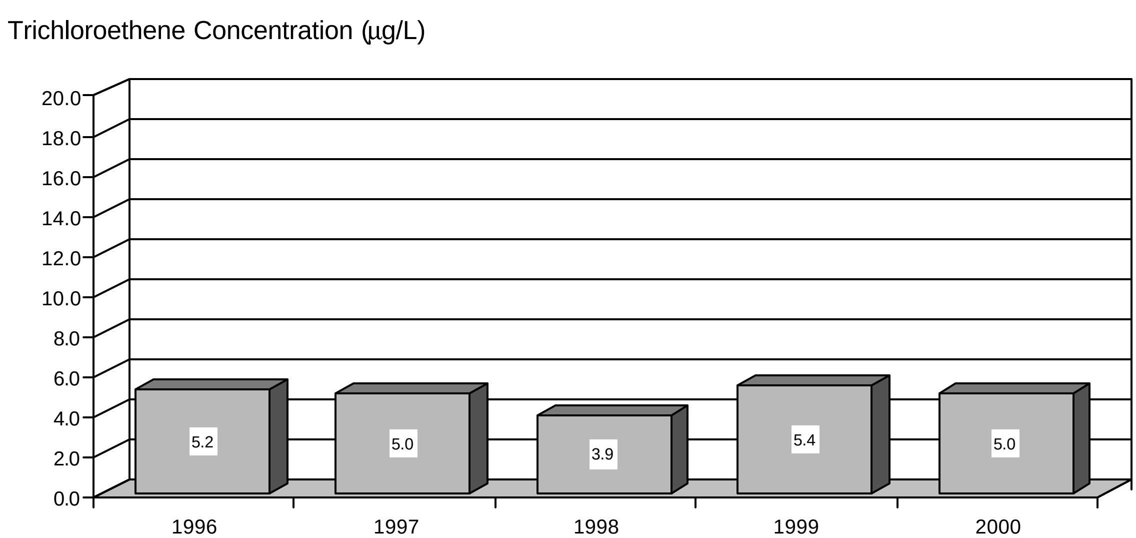
(MCL for trichloroethene = 5 µg/L)

Figure 6-10. Annual Average Tritium Concentration for Seep 0601, 1996 - 2000



(MCL for tritium = 20 nCi/L)

Figure 6-11. Annual Average Indicator VOC Concentration for Seep 0601, 1996 - 2000



(MCL for trichloroethene = 5 µg/L)